

and geology at Jena has attempted to do justice to this side of Goethe's activity. Realising the danger of unconsciously misrepresenting Goethe's position by attempting to interpret his work in the light of our present knowledge, Prof. Linck has wisely allowed Goethe to explain himself in extracts from his published writings and correspondence. Goethe appears to have been attracted to the study of mineralogy partly by the reopening of the Ilmenau mines, and partly through the influence of the Freiberg school. Further, his official position brought him into contact with mining and geological problems, and his business instincts led him to take an interest in any discovery likely to be of practical use.

Goethe, in fact, was by nature a realist, and even his muse was happiest when inspired by a striking event or by a beautiful scene. His realistic tendencies led him to become an ardent collector of minerals, rocks, and fossils, which he regarded from a natural history point of view. But he lived in a time when the classification of minerals by their more obvious external characters and by their mode of occurrence was passing away. On the one hand, analytical chemistry was revealing their composition; on the other, crystallography was reducing to order the apparent complexity of the crystal forms. Goethe, however, held by the old system. He realised, it is true, the importance of chemistry—"I cannot get a step further in mineralogy without chemistry"—but it was a study for which he appears to have had but little aptitude. His appreciation of crystallography was smaller still; witness his statement, "Crystallography is not productive—and leads to no results, especially now that so many isomorphous bodies have been discovered of different compositions." Goethe appears, indeed, to have regarded the progress of these sciences with some misgiving, for he says:—"Mineralogy is in danger of being devoured by crystallography, where form is all-important. It is in danger of being devoured by chemistry, which looks only for general laws and is indifferent to form. It may also be in danger of being devoured by geology, for the latter is only concerned with modes of occurrence." As an adherent, then, of a system which had attained practically the fullest development of which it was capable, the field open to him was not extensive, but within its limits he did good work. His description of the Carlsbad felspar twins, for example, was excellent, and we owe many interesting observations to his studies on crystal-genesis and on the occurrence and associations of minerals. Among his collections, those from the neighbourhood of Carlsbad were the most important, but Thuringia, the Harz, and Italy were laid under contribution as well, "for the mineralogist must be like a stag, and browse irrespective of frontiers."

Early in his studies Goethe felt his weakness on the scientific side, and to remedy it caused W. Voigt to be sent to Freiberg. Voigt on his return instructed him in nomenclature, and he began to arrange and label his collections, for "every properly recorded observation is invaluable to posterity." His activity as a collector soon impressed on him the importance of good maps, and the interest thus stimulated led to the

preparation of a mineralogical map of the Ilmenau district, subsequently extended to neighbouring regions. It bore further fruit in several practical suggestions as to the best method of printing and colouring such maps. The colour scheme employed to-day is in essentials that proposed by him.

Perhaps Goethe makes his greatest claim to be considered a geologist by his attitude towards the problem of the history of the earth. Living at a time of conflict between Neptunists and Vulcanists, his mind was too well balanced to allow him to become a bigoted partisan or the slave of a hypothesis. The uniformity of nature was his watchword, and he never lost sight of this principle, whether discussing the erratic blocks of Northern Germany or the basalts of Bohemia.

At the conclusion of his review of Goethe's essays in mineralogy and geology, Prof. Linck asks the pertinent question, Are such studies to be put aside with a smile and a shrug of the shoulders as the well-meant efforts of an amateur and nothing more? Prof. Linck thinks not. He points out that many contemporaries well qualified to judge thought highly of the work, and he holds that Goethe is justly entitled to an honourable place among the pioneers in mineralogy and geology. We venture to think that anyone who follows the case presented in his pages will endorse his verdict.

THE CHEMICAL STRUCTURE OF CELLULOSE.

Researches on Cellulose, II. (1900-1905). By C. F. Cross and E. J. Bevan. Pp. xi+184. (London: Longmans, Green and Co.) Price 7s. 6d. net.

IN the course of their extended researches on the chemistry of cellulose, the authors of this work have gradually become dissatisfied with all the numerous attempts which have from time to time been made to represent the chemical structure of this substance by means of ordinary constitutional formulæ. The fundamental basis for such a representation—the knowledge of the molecular weight—has always been and is still lacking, and in its absence the chemist has perforce limited himself to endeavouring to assign a chemical constitution to some comparatively small unit containing six, or some multiple of six, carbon atoms, and has usually regarded the complete unknown molecule of cellulose as a polymeride of this. A certain measure of success has attended these efforts, particularly as regards the relation of the final products of such processes as nitration or hydrolysis to the original "unit."

The authors, however, consider all such formulæ to be totally inadequate to express the greater number of the chemical changes which cellulose is capable of undergoing. In place of the purely chemical idea of cellulose as a complex polymeride of preformed groups of rigid configuration, they propose to substitute the conception of cellulose as a colloidal aggregate which may be considered to react "as a labile complex of groups of varying dimensions representing a state of matter somewhat analogous

to that of a saline electrolyte—that is, it reacts rather as a solution-aggregate than by a succession of molecular combinations; the masses actually reacting following the stoichiometrical ratios proper to the dimensions of these ultimate groups, and retaining their relationship in the aggregate, which is thus progressively modified by the entrance of the new groups" (p. 7).

Owing to the prevailing ignorance as to the nature of colloids and the relation of this condition of a substance to its chemical character, both the language and the ideas employed by the authors in the development of their thesis are, as they themselves admit, somewhat vague, and it is difficult to realise exactly wherein lies the advantage of the new standpoint over the old view of cellulose as a highly complex molecule, coupled with the recognition of the fact that both the parent substance and many of its derivatives are only known as colloids. There can, however, be no doubt that sufficient attention has not hitherto been paid to this cardinal fact of the colloidal character of cellulose, and the authors do good service by insisting upon it and showing very clearly how this conception may serve to suggest many hopeful lines of investigation on questions of scientific and technical importance.

The first section of the book contains the development of these ideas, together with a general account of the chemistry of cellulose. In the second section are brought together the more important researches on the subject of cellulose which have appeared during the period 1900–5. An impartial abstract of each investigation is given, followed by critical notes on the bearing of the results on the great question of the chemical structure of cellulose. The third and concluding section deals with the progress made on the technical side of the subject during the same period. This book therefore forms a supplement to the two volumes which have preceded it, but it is valuable, not merely as a compendium of the latest researches on cellulose, but much more as a thoughtful and suggestive contribution to our knowledge of the chemical and physical structure of this important natural product.

ARTHUR HARDEN.

OUR BOOK SHELF.

Cours d'Astronomie. Première partie: Astronomie Théorique. By H. Andoyer. Pp. 221. (Paris: A. Hermann, 1906.) Price 9 francs.

THERE is no preface to explain the scope of Prof. Andoyer's book, but it appears to consist of the notes of a course of lectures on spherical astronomy. Now, it is characteristic of lecture-notes to offer definitions in place of explanations; also, they have a tendency to disintegrate into a bewildering array of unconnected problems. The book has these defects. But as an exposition of the art of manipulating the very cumbersome formulæ of spherical trigonometry which pervade astronomy, it will fulfil a useful purpose. The mathematical treatment is good and concise; moreover, the problems treated are mostly of a severely practical character. The author has wisely taken as his guide the *Connaissance des Temps*; he refers to

it continually, and there is very little in the book which has not some direct bearing on the use or construction of its tables.

The usual subjects are fully treated, refraction, parallax, aberration, precession, and nutation; there is a brief account of motion in an ellipse. The chapter on the geocentric motions of the planets is not very satisfactory; the student who has followed the lengthy investigations of the preceding chapters might safely have been offered something more advanced and more approximate to the practical problem than the very rudimentary theory here given. The apparent motion of satellites is in like manner inadequately treated. The last chapter, which deals with eclipses, is, perhaps, the best feature of the book; solar eclipses are treated in a very thorough and interesting way. The general accuracy and precision of the book are admirable; the approximations and assumptions made are always clearly stated. Occasionally, however, precision is carried to excess, as, for instance, when the proper motion of Arcturus is given in seconds per *tropical* year (p. 141).

It is a pity that the book is not *printed* in the usual way. It appears to have been reproduced in facsimile from the written manuscript. This is a needless sacrifice of clearness, and must to some extent diminish its value as a book for reference.

A. S. E.

Les Révélationes de l'Écriture d'après un Contrôle scientifique. By Alfred Binet. Pp. viii+260. (Paris: Félix Alcan, 1906.) Price 5 francs.

In this book M. Binet, the well-known experimental psychologist of the Sorbonne, describes an investigation of the art of telling intelligence and character from handwriting. After some preliminary inquiries to ascertain how far "graphologists" are able to recognise sex and age by means of writing, M. Binet submitted to several experts specimens of the handwriting of people of great intellectual eminence, such as Renan, Dumas fils, and Claude Bernard, together with others obtained from persons known to be of ordinary intelligence. The general result was to show that, though the experts were more often right than wrong, they were liable to the grossest errors, as in one case in which Renan was judged to be of mediocre and uncultivated intelligence, an opinion into which the expert appears to have been led by the repetition of a word in the sample.

In the estimation of character a similar result was obtained. This was tested by submitting to the graphologists specimens of the handwriting of notorious criminals to be distinguished from the writing of people of good moral reputation. Here again the experts were usually more or less right, but bad mistakes were made, as when a man who had murdered his mother with every circumstance of brutality was judged to be a young girl, "*douce, modeste, et peu coquette*." In the simple distinction of the two classes of people concerned in the tests, the number of correct answers was distinctly greater than should have been expected from chance, and this preponderance of correct judgments was greater in the estimation of intelligence than in that of character; but it is not clear that clues derived from the subject-matter of the samples of writing were altogether excluded in the former case.

In M. Binet's hands the graphologists themselves became the subjects of investigation, and it may perhaps be regarded as evidence that their art has a scientific basis that some of the experts showed themselves greatly superior to others, under an experimental procedure which deprived them of many of those adventitious aids on which it is probable they usually rely.